

EFFECTIVE BRACING SYSTEM FOR TRANSMISSIONLINE TOWERS

NOR NAJJATULNAJIHAH BT MOHD
HAMIZUL

B. ENG(HONS.) CIVIL ENGINEERING

UNIVERSITI MALAYSIA PAHANG



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(Student's Signature)

Full Name : NOR NAJJATULNAJIHAH BT MOHD HAMIZUL

ID Number : AA15060

Date : 31 May 2019

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NOR NAJJATULNAJIHAH BT MOHD HAMIZUL

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ABSTRAK

Menara talian penghantaran terdedah kepada beban angin yang menjadikan menara tersebut perlu direka supaya ia boleh menahan beban angin. Menara talian penghantaran harus mempunyai ketinggian yang efektif dan system pendakap yang berkesan untuk memberikan prestasi yang lebih baik bagi menahan beban. Dalam kajian ini, menara talian penghantaran sejenis penggantungan ini direka dan dimodelkan menggunakan Staadpro V8i. Terdapat dua jenis system pendakap yang telah diterapkan kepada menara. Menara ini dimodelkan dengan ketinggian 39 m, 49 m, dan 100 m yang akan kendalikan tiga kelajuan iaitu 32.5 m/s, 33.5 m/s dan 40 m/s di dalam Staadpro V8i. Berdasarkan perbandingan yang telah dibuat, system pendakap yang efektif bagi menara berketinggian 39 m dan 49 m adalah pendakap jenis K, manakala menara berketinggian 100 m menunjukkan pendakap jenis X adalah lebih efektif. Dari segi anjakan, menara 39 m dengan sistem pendakap K dengan kelajuan angin 32.5 m/s, 33.5 m/s dan 40 m/s menunjukkan ia berkurang daripada system pendakap jenis X sama seperti menara berketinggian 49 m. Walaubagaimanapun, bagi menara dengan ketinggian 100 m, sistem pendakap K meningkat lebih daripada sistem pendakap X. Kemudian, dari segi beban menara pula, menara berketinggian 39 m dengan kelajuan angin 32.5 m/s, 33.5 m/s dan 40 m/s menunjukkan sistem pendakap K berkuaran daripada sistem pendakap X sama seperti menara berketinggian 49 m. Bagi menara dengan ketinggian 100 m, sistem pendakap K mempunyai beban menara yang lebih tinggi 46% berbanding sistem pendakap X.

ABSTRACT

Transmission line tower which usually affected by the wind load need to be designed to resist the wind load. The transmission line tower should have effective height and effective bracing system in order to give better performance to resist the load. In this research, the transmission line tower was in the form of suspension tower were modelled and designed in Staadpro V8i. Two types of bracing system, K and X system were assigned to the tower. These towers were modeled by considering the effects of tower height which include 39 m, 49 m and 100 m height and were developed with three wind speeds which include 32.5 m/s, 33.5 m/s and 40 m/s in Staadpro V8i. Comparison was made based on the displacement and axial load. It was found that the tower with height 39 m and 49 m gives K bracing system as the effective bracing system and tower with height 100 m showed X bracing system is the effective bracing system. In terms of displacement, 39 m tower with K bracing system that was subjected to 32.5 m/s, 33.5 m/s, and 40 m/s wind speed showed that the displacement was reduced similar to that of 49 m tower height. In contrast, 100 m tower height with K bracing system showed that the displacement increased from the X bracing system. In terms of axial load, 39 m tower subjected to the wind speed of 32.5 m/s, 33.5 m/s, and 40 m/s showed that the K bracing system reduced from the X bracing system, similar to that of 49 m tower. As for the 100 m tower, K bracing system exhibited higher axial load which approximately 46% compared to the X bracing system.

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LIST OF SYMBOLS

P	Design wind pressure
V_{des}	Design wind speed
C_{fig}	Aerodynamic shape factor
C_{dyn}	Dynamic response factor

LIST OF ABBREVIATIONS

STAAD	Structural analysis design
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CHAPTER 1

INTRODUCTION

1.1 Background

Transmission line tower is one of the communication towers adapted into the world which use electrical power to generate large transmission over all areas required. The existence of this tower in the communication sector revealed that in the modern era, large power of electricity is needed to supply the communication tower with enough energy. The increasing uses of electricity in this sector give positive impact toward economical industry, which generate electricity being an important part in the sector. Transmission line tower structure are made of steel with foundation on the ground, which steel structure using economical materials that act as an element of the structure. A steel structure, arrangement using trusses which this kind of structure, arrangement can sustain heavy load from above structure. Trusses using bracing system are usually known as the system that excels in transferring the load from above structure to the ground and it can provide horizontal stability toward structure. The kind of tower structure which widely used are usually square or triangular in shape with different bracing system of the trusses depends on the height and the range of the communication tower. The adoption of different bracing system and different shape of the structure to ensure that the structure can resist the displacement together in the event of wind load toward the structure itself.

Transmission line tower can be classified into two which is suspension and tension towers. The suspension tower is being analysed in the research to have the effective tower with suitable bracing system and effective height to resist the wind load and reduce the displacement effect. The height of the tower and bracing system affect the performance of the communication tower in receiving signal from the cell phones and expand their network. In order to achieve high performance of the tower, height of the tower must suitable with the wind load, bracing system and load that will resist by the tower.

Construction of the transmission line tower must consider the surrounding where the disaster or seismic load that have potential to stuck the area surrounding. All the element that consider during the construction of the tower will give future impact of the structure and the coverage of the communication network. However, the effectiveness of the parameter toward the transmission tower can be modelled using the software of Staadpro V8i which the software will model the structure and depicts the effective parameter required for the tower and the advantage and disadvantages of ivory tower designed. This software helps in analysing the whole structure of the transmission tower with optimum load and strength that can resist by the structure. The most effective and economical tower will give an advantage in the construction industry, which reduce the cost, but increasing the benefit of the construction.

1.2 Problem statement

Wind is known as one of the resistance encountered by the transmission line tower, which subjected to the structure of bracing system implemented in the tower. In order to resist the wind load, several types of bracing system are being analysed to state the most effective bracing system to encounter the wind load. Communication towers are very prone to wind loads such that they are needed to be designed to resist wind loads to make the structure at least for life safe in the event of natural calamities like HUD-HUD(Phanindranath, 2017). Besides the types of bracing system, the height of the tower also being analysed since the height of the towerinfluenced the displacement of the tower. It was observed that from 30m to 40m tower height, the increase in displacement is nearly linear but as the height increases from 40m to 50m there is a steep increase in the displacement in all the zones (Sharma, Duggal, Singh, & Sachan, 2015). The effective height of the tower is analysed within the suitable height of the tower to ensure that the height prone with the displacement in order to get the effective height and the effect of the displacement to the tower.

1.3 Research Objectives

The main objectives of this research include:

- i. To determine the displacement effect to the transmission line tower in the event of wind load

- ii. To determine the most effective bracing system for communication towers in the event of wind load effects
- iii. To identify the most effective height of the transmission line tower with respect to wind zone

1.4 Significance of research

Transmission line tower is one of the communication towers that transmit signal through the devices. In order to complete the transmission of signal, the tower must be design prone to the function of the tower. Types of bracing system assigned to the tower are one of the parameters that affect to the effectiveness of the tower function. There are several types of bracing system analysed and compared to find the most effective bracing system which is K and X bracing system. These are bracing system that commonly used in the structural industry to build a communication tower. In order to have the effective bracing system, this research considered only two of the bracing system. The height of the tower that were analysed is within the minimum and maximum height to have the optimum height of tower to act efficiently. The height of the tower also used to identify the effect toward the displacement.

1.5 Scopes of research

The analysis of tower is focused on the suspension transmission line tower. The analysis of the transmission line tower is using two types of different bracing system which is K and X bracing system in order to compare the effectiveness. The different types of bracing system for the substation analysed using Staadpro V8i software. The height of the transmission line tower that analysed is 39 m, 49 m and 100 m. The difference in term of height is to obtain the minimum and the maximum effective height of the tower to carry the electric voltage. The height of the tower affected by external load which is wind load. Wind load become one of the parameters in this research which the wind load that acted on the tower is 33.5 m/s, 32.5 m/s and 40.0 m/s. The wind load is taken from zone I and zone II and maximum wind speed which to see if the tower can resist the maximum wind load with different types of bracing system and different height. Transmission line tower can be designed using three legged tower and four legged towers. In this research four legged towers were chosen to determine the effectiveness of the

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